PHSB STUDIES

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EPIDEMIOLOGY OF SUDDEN INFANT DEATH IN NORTH CAROLINA:

Do Cases Tend to Cluster?

In the last decade, sudden infant death syndrome (SIDS) has become widely recognized as the leading category of postneonatal deaths, that is, deaths to children 28 days to one year of age. It occurs at a rate of two to three per 1,000 live births (3,6,9,11,15) and is responsible for approximately 160 to 180 deaths each year in North Carolina.

Many theories have been proposed to explain the etiology of SIDS. Proposed causative agents, ranging from viral agents and infectious diseases to simple climactic changes, have been listed by Beckwith (1).

Several epidemiologic studies have suggested that SIDS deaths tend to cluster, especially seasonally (1,5-7,18). Beyond this, no known published reports in the United States have shown statistically whether SIDS deaths actually do cluster in certain time and space dimensions. In fact, a study by Froggatt, et al. (6) in Northern Ireland is the only known published report to statistically examine the question of clustering, and that study was done before a specific SIDS code was developed in 1974.

With the present availability of SIDS data by county, the question of clustering of SIDS deaths in North Carolina is addressed. In particular, the purpose of this report is threefold: (a) to describe the epidemiology of SIDS cases occurring in North Carolina, (b) to test the null hypothesis that SIDS occur randomly throughout the state, that is, that no apparent clustering of SIDS exists in North Carolina and (c) to describe the time and space parameters which adequately portray the clusters if the null hypothesis is rejected.

A second component of this study involves examining SIDS cases on the Medical Examiner's (ME) files and the Vital Statistics (VS) files. The purpose here is to determine the extent to which the two files disagree and to provide explanations for the differences. This component is important because results provide the basis for determining which record system to use.

Ascertainment of SIDS Cases

The Office of the Chief Medical Examiner is charged with investigating and certifying all deaths due to violent, unusual or unidentified causes. These investigations are carried out through a statewide system of regional pathologists and licensed county medical examiners. In the case of apparent SIDS, an autopsy is required to document that no specific underlying cause of death can be determined.

Through normal death registration channels, the Vital Records Branch of the Division of Health Services receives death certificates for SIDS cases. Almost always, these should be the same as cases reported to the Medical Examiner System; however, discrepancies were found when infant deaths on the two computerized files were matched, using 1974 and 1977 as test years. Discrepancies involved the following:

- N.C. residents died of out-of-state and therefore were not subject to investigation by an N.C. medical examiner.
- Cause of death on the death certificate was amended after closure of the VS computerized files.
- Death was recorded on a "Medical Examiner Death Certificate" but was not found on the ME file.
- Death was recorded on a "Medical Examiner Death Certificate" and "pending" was the only cause given.
- Death was not recorded on a "Medical Examiner Death Certificate" but SIDS was mentioned.
- ME and VS files involved different coding conventions for underlying cause.

Regarding the latter, when SIDS is jointly reported with a "more definitive cause," the VS file shows the latter as per underlying cause-of-death coding rules. The ME file shows SIDS. This disparity undoubtedly involves the problem described by Valdes-Dapena, that "virtually all pathologists, who have performed substantial numbers of infant autopsies, have encountered the insoluble problem of what to do about the case in which there are identifiable lesions of minimal to moderate intensity which, of themselves, would not appear to have caused death" (18).

Each data source is thus beset with advantages and disadvantages, and one is hard-pressed to decide which source to use. However, it does appear that the VS files have fewer missing cases and may involve more uniform coding rules. Also, the National Center for Health Statistics has noted that the inclusion of deaths mentioning SIDS but coded to a "more definitive cause" may give a more accurate picture of the size of the SIDS problem (13). Thus, a SIDS case is herein defined as a resident death under one year of age for which SIDS is mentioned on the death certificate regardless of whether it is coded as the underlying cause (note exceptions described below). This includes VS cases not autopsied as well as those not found on the ME files.

Epidemiologic Distribution of SIDS Cases

SIDS deaths occurring during 1974-78 were partitioned according to July 1-June 30 years to avoid splitting the peak winter months. Therefore, data cover 4 fiscal years rather than five calendar years. Table 1 shows the annual and 4-year average SIDS rates for North Carolina and the 100 counties. Since only underlying cause was coded in 1974, the period July-December 1974 excludes some cases in which SIDS was mentioned but not coded as the underlying cause.

Over the 4-year period, 667 resident infant death certificates mentioned SIDS; the resulting rate was 2.0 deaths per 1,000 live births. The median rate for the 100 counties was 1.9, ranging from zero in 13 counties to 9.6 in Anson.

In large measure, counties with the higher rates are contiguous to each other. In the northeast, 6 counties—Warren, Halifax, Northampton, Hertford, Bertie and Washington—had rates ranging from 4.1 to 6.3. In the southern part of the state, 6 counties—Hoke, Scotland, Robeson, Bladen, Columbus and Pender—had rates of 3.5 and higher. With a rate of 9.6, Anson is in close proximity to the latter 6 counties.

Division of the counties into six health service areas reveals that the Eastern and Cardinal health service areas, which comprise the eastern part of North Carolina, each had rates of 2.7 per 1,000 live births. Rates were 1.6 in the Capital, Southern Piedmont and Southern Piedmont and 1.5 in the Western health service area. The same relative distribution occurred each year.

TABLE 1

NUMBER AND RATE[1] OF INFANT DEATHS WITH MENTION OF SUDDEN INFANT DEATH SYNDROME[2] BY COUNTY AND YEAR[3], NORTH CARDLINA, 1974-78

County	1974-75 No.	1974-75 Rate	1975-76 No.	1975-76 Rate	1976-77 No.	1976-77 Rate	1977-78 No.	1977-78 Rate	1974-78 No.	1974-78 Rate
Alamance	4	3.2	3	2.6	3	2.7	3	2.6	13	2.8
Alexander	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Alleghany	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Anson	4	11.1	4	10.8	3	7.2	4	9.5	15	9.6
Ashe	1	3.6	0	0.0	0	0.0	0	0.0	1	0.9
Avery	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Beeufort	0	0.0	2	3.0	3	4.3	2	3.0	7	2.6
Bertie	0	0.0	3	9.2	3	9.1	0	0.0	6	4.5
Bladen	5	10.6	0	0.0	1	2.3	2	4.5	8	4.5
Brunswick	1	1.6	1	1.9	0	0.0	3	5.9	5	2.3
Buncombe	3	1.6	2	1.1	3	1.6	1	0.5	9	1.2
Burke	0	0.0	1	1.2	2	2.3	2	2.2	5	1.4
Cabarrus	3	2.9	0	0.0	0	0.0	0	0.0	3	0.7
Caldwell	1	1.1	0	0.0	4	4.4	1	1.1	6	1.7
Camden	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Carteret	1	1.7	2	3.5	0	0.0	2	3.2	5	2.1
Caswell	0	0.0	1	4.2	0	0.0	1	4.4	2	1.9
Catewba	1	0.7	1	0.7	0	0.0	3	2.1	5	0.9
Chetham	1	2.7	0	0.0	0	0.0	1	2.2	2	1.2
Cherokee	0	0.0	0	0.0	1	4.2	1	4.1	2	1.9
Chowan	0	0.0	0	0.0	1	4.7	0	0.0	1	1.3
Clay	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cleveland	2	1.5	4	3.4	3	2.5	1	0.9	10	2.1
Columbus	5	6.1	2	2.4	4	4.5	4	4.9	15	4.5
Craven	2	1.4	6	4.0	4	2.7	1	0.7	13	2.2
Cumberland	8	1.6	12	2.4	12	2.3	6	1.2	38	1.9
Currituck	0	0.0	0	0.0	0	0.0	1	6.6	1	2.0
Dare	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Davidson	0	0.0	2	1.6	2	1.4	4	2.9	8	1.5
Davie	1	3.1	0	0.0	0	0.0	0	0.0	1	0.8
Duplin	2	3.0	2	3.4	0	0.0	0	0.0	4	1.6
Durham	2	1.0	6	3.2	3	1.5	5	2.4	16	2.0
Edgecombe	1	1.1	4	5.0	1	1.0	4	4.2	10	2.7
Forsyth	3	1.0	0	0.0	6	2.0	1	0.3	10	0.8
Franklin	0	0.0	0	0.0	1	2.9	1	2.8	2	1.4
Gaston	4	1.6	1	0.5	2	0.9	4	1.9	11	1.2
Gates	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Graham	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Granville	2	4.6	0	0.0	1	2.3	1	2.5	4	2.4
Greene	1	4.5	0	0.0	1	4.1	2	9.0	4	4.6
Guilford	8	2.0	5	1.3	5	1.2	5	1.2	23	1.4
Halifax	2	2.2	4	4.4	6	7.0	6	6.5	18	5.0
Harnett	1	1.0	3	3.3	0	0.0	2	2.0	6	1.6
Haywood	1	1.7	0	0.0	0	0.0	1	2.0	2	0.9
Henderson	2	3.1	1	1.6	1	1.5	1	1.5	5	1.9
Hertford	1	3.0	1	3.0	1	2.5	4	10.2	7	4.8
Hoke	4	9.6	1	3.1	1	2.5	1	2.8	7	4.7
Hyde	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Iredell	1	0.9	0	0.0	0	0.0	3	2.8	4	1.0
Jackson	2	6.9	0	0.0	0	0.0	0	0.0	2	1.8
Johnston	1	1.0	3	3.1	1	1.0	1	1.0	6	1.5
Jones	1	7.4	0	0.0	0	0.0	0	0.0	1	1.7
Lee	0	0.0	0	0.0	2	3.3	3	5.1	5	2.2
Lenoir	3	3.3	4	4.4	1	1.2	2	2.2	10	2.9
Lincoln	1	1.8	1	2.0	3	5.4	3	5.2	8	3.6
McDowell	0	0.0	1	2.3	2	4.5	2	4.1	5	2.6
Macon	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Madison	0	0.0	1	5.5	1	5.3	0	0.0	2	2.6
Martin	2	5.0	0	0.0	0	0.0	0	0.0	2	1.3
Mecklenburg	12	2.1	12	2.3	9	1.7	11	2.0	44	2.0
Mitchell	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Montgomery	0	0.0	0	0.0	2	6.7	1	3.0	3	2.4
Moore	1	1.5	3	4.7	1	1.4	0	0.0	5	1.9
Nash	2	2.0	3	3.1	1	1.0	2	1.9	8	2.0
New Hanover	3	2.1	5	3.8	4	2.8	0	0.0	12	2.2
Northampton	0	0.0	2	6.1	1	2.7	6	17.1	9	6.3
Onslow	6	2.2	11	3.9	5	1.8	7	2.5	29	2.6
Orange	2	2.5	0	0.0	2	2.6	0	0.0	4	1.3
Pamlico	0	0.0	0	0.0	1	6.3	0	0.0	1	1.8
Pasquotank	2	5.0	0	0.0	1	2.5	0	0.0	3	1.8
Pender	0	0.0	0	0.0	0	0.0	4	13.4	4	3.3
Perquimans	0	0.0	1	8.7	0	0.0	0	0.0	1	2.1
Person	2	5.1	0	0.0	0	0.0	2	5.1	4	2.6
Pitt	5	4.0	4	3.3	4	3.1	1	0.8	14	2.7
Polk	0	0.0	0	0.0	0	0.0	1	7.7	1	1.9
Randolph	3	2.6	1	0.9	1	0.9	2	1.8	7	1.6
Richmond	1	1.4	0	0.0	1	1.5	2	2.8	4	1.5
Robeson	7	3.5	6	3.1	8	4.0	10	5.1	31	3.9
Rockingham	3	2.6	2	1.9	4	3.6	7	6.3	16	3.6
Rowan	0	0.0	0	0.0	3	2.6	0	0.0	3	0.7
Rutherford	3	3.9	3	4.2	2	2.7	4	5.3	12	4.0
Sampson	0	0.0	2	2.7	1	1.3	1	1.3	4	1.3
Scotland	2	3.5	1	1.9	4	6.6	1	1.8	8	3.5
Stanly	1	1.7	3	5.4	0	0.0	1	1.6	5	2.1
Stokes	0	0.0	0	0.0	1	2.7	0	0.0	1	0.6
Surry	3	3.7	1	1.3	1	1.2	0	0.0	5	1.6
Swain	0	0.0	1	6.2	0	0.0	2	11.2	3	4.4
Transylvania	0	0.0	1	3.2	2	6.7	0	0.0	3	2.6
Tyrrell	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Union	0	0.0	1	1.1	2	2.0	1	1.0	4	1.0
Vance	0	0.0	1	1.9	2	3.6	1	1.7	4	1.8
Wake	3	0.8	5	1.5	2	0.5	6	1.7	16	1.1
Warren	1	4.0	0	0.0	2	8.0	1	3.8	4	4.1
Washington	2	8.3	2	8.6	0	0.0	1	4.3	5	5.1
Watauga	0	0.0	0	0.0	0	0.0	1	3.0	1	0.8
Wayne	2	1.2	5	3.1	5	2.9	6	3.6	18	2.7
Wilkes	2	2.4	1	1.3	0	0.0	1	1.2	4	1.3
Wilson	3	3.3	1	1.1	4	4.2	3	3.2	11	3.0
Yadkin	1	2.8	0	0.0	0	0.0	0	0.0	1	0.8
Yancey	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
N.C.	160	1.9	162	2.0	164	2.0	181	2.2	667	2.0

[1]Deeths per 1,000 live births. [2]These are infant deaths in which the underlying cause of death is coded as 7950 or in which sudden infant death syndrome was mentioned on the death certificate although the underlying cause was not coded as such. [3]Defined as July 1-June 30.

Studies of the urban-rural nature of SIDS have generally yielded conflicting results (1,2,8,9,16-18). However, like Standfest's study of upstate New York (15), Blok's study of North Carolina SIDS (3) revealed no significant difference between urban and rural areas. Based on correlations between county SIDS rates and each of percent rural, percent rural farm and percent rural non-farm, results of this study support findings for no urban-rural difference.

Several studies have shown males to be at higher risk of SIDS than are females (1-3,6,15-18). Present results support these findings with 1974-78 SIDS rates of 2.27 for males and 1.77 for females being significantly different by the chi-square criterion. An even more striking difference is observed between whites and nonwhites with the nonwhite rate being 3 times higher.

Table 2 shows annual and 4-year average SIDS rates for races, sexes and race-sex groups. The highest rate occurs among nonwhite males, the lowest among white females with a risk ratio of more than 4 to 1. The difference between males and females is significant for whites but not nonwhites.

TABLE 2

NUMBER AND RATE[1] OF INFANT DEATHS WITH MENTION OF SUDDEN INFANT DEATH SYNDROME BY YEAR[2] AND BY RACE AND SEX, NORTH CAROLINA, 1974-78

Race-Sex Specific Group	1974-75		1975-76		1976-77		1977-78		1974-78	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
White	69	1.19	67	1.24	61	1.08	71	1.26	268	1.19
Nonwhite	91	3.44	95	3.77	103	3.87	110	4.10	399	3.80
Male	93	2.16	85	2.10	101	2.37	104	2.42	383	2.27
Female	67	1.63	77	1.99	63	1.55	77	1.91	284	1.77
White Males	46	1.55	39	1.41	39	1.35	38	1.30	162	1.40
White Females	23	0.82	28	1.07	22	0.80	33	1.21	106	0.97
Nonwhite Males	47	3.52	46	3.62	62	4.57	66	4.80	221	4.14
Nonwhite Females	44	3.36	49	3.93	41	3.14	44	3.37	178	3.44
Total	160	1.90	162	2.05	164	1.97	181	2.17	667	2.02

[1]Deaths per 1,000 live births.

[2]Defined as July 1 - June 30.

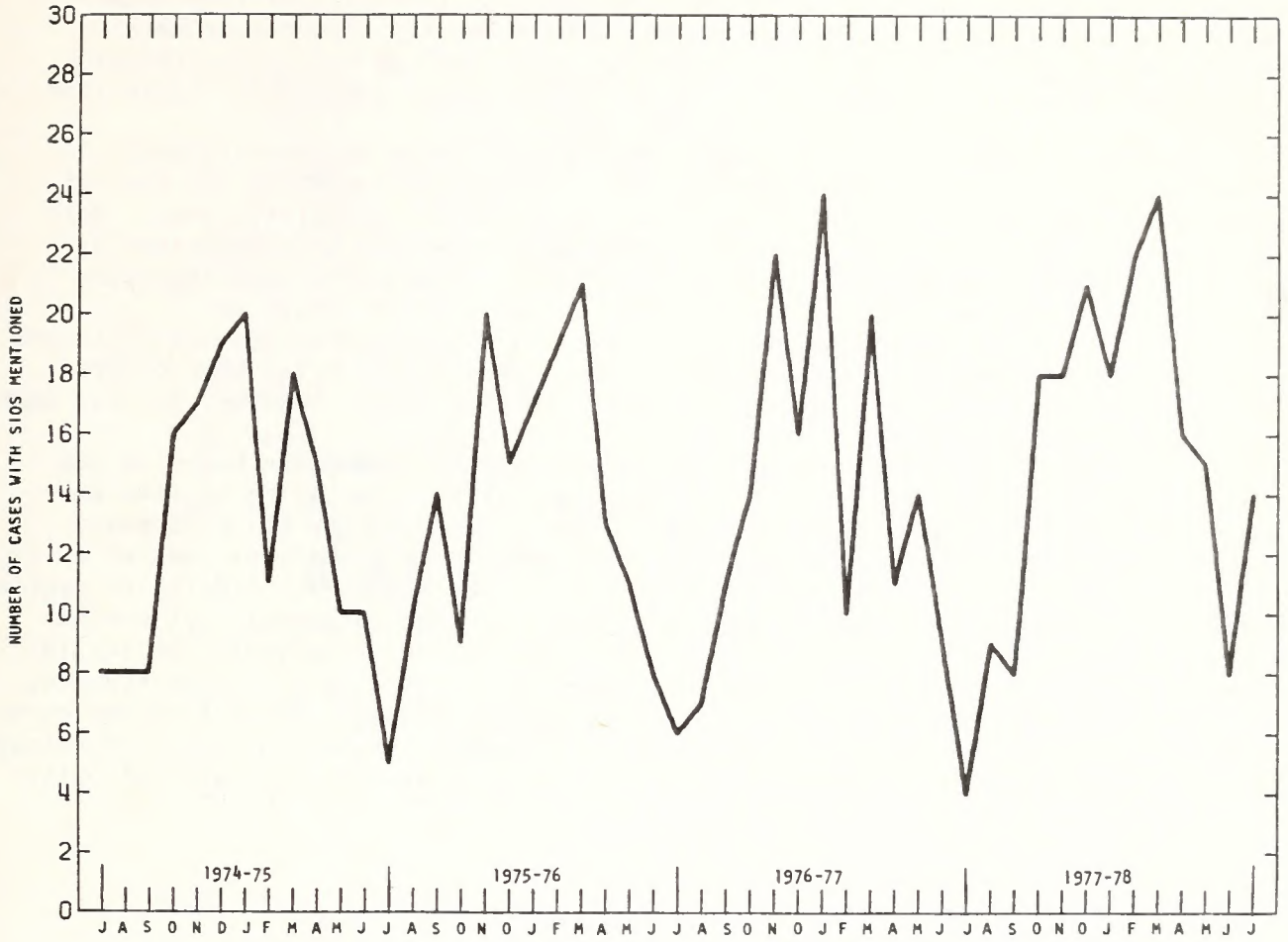
The percent distribution of SIDS deaths reveals that over 80% occurred during the first 4 months of life, nearly 90% during the first five months. Most (62%) occurred between the first and third months.

The figure on the following page shows the distribution of SIDS by month from July 1974 through June 1978. The winter excess (January-March) is consistent with findings of other studies (1,5,6,9,12,15-18).

Space-Time Clustering

It has been shown that SIDS deaths are more common in certain contiguous N.C. counties and occur more frequently in winter. To determine statistically whether SIDS do cluster in time and space, the Ederer-Myers-Mantel procedure (10) was applied to the 4 years of N.C. data. Spatial units were 4-year county units, 4-year Health

RESIDENT INFANT DEATHS WITH MENTION OF
SUDDEN INFANT DEATH SYNOROME IN NORTH CAROLINA,
BY MONTH, JULY 1974 - JUNE 1978



Service Area (HSA) units and 4-year county units within HSA. Results indicate no statistically significant difference between the observed and expected maxima in one year or in two successive years of the 4-year spatial unit. Thus, using the presently described time and space dimensions, we cannot reject the null hypothesis of randomness. However, as Ederer-Myers-Mantel noted, "clusters may remain undetected if the unit of study is too large or too small" (4).

Discussion

This study has described the epidemiologic distribution of SIDS cases in North Carolina from 1974 through 1978. As supported in other studies, males and nonwhites, especially nonwhite males, experienced significantly higher SIDS rates than did other race-sex groups. While it has been suggested that the predominance of nonwhite cases is no greater than for infant mortality generally (6,18), this would not appear to be true in North Carolina where race is more highly discriminating for SIDS than for total infant mortality. At the same time, as those studies also suggest, sex appears no more discriminating for SIDS than for total infant mortality in North Carolina.

A definite seasonal pattern exists, one which seems to differ from that of other infant deaths taken collectively. The greatest incidence of SIDS occurs during the colder months, which may suggest a relationship with one or more environmental factors that vary by season and year, such as viral respiratory infections. The collective distribution of infant deaths from causes other than SIDS appears to vary randomly by month and season.

This study also shows that SIDS is more prevalent in the eastern part of the state, possibly due to the fact that eastern counties are among the poorest counties in the state and usually have the highest infant mortality rates. Both factors—low economic status and high infant mortality—have been suggested as positive correlates of the SIDS rate (6,14,16-18). It has also been suggested that underreporting of SIDS may be a problem in some western counties.

Visual examination of the pattern of rates among counties suggests that some counties or pockets of contiguous counties experience higher rates than others. This kind of spatial cluster was not addressed in this study; however, further work in this area is in progress.

The cluster or pattern recognition aspects of the study were based on the Ederer-Meyer-Mantel procedure which, although a test for clustering in time and space, is sensitive mainly to clustering in time. Based on the 667 SIDS cases reported during the four-year period and using counties and HSA's as spatial units, no tendency of SIDS to cluster in particular years was detected. A definite cyclic pattern for months within year is apparent; however, that pattern is yet another matter and does not affect clustering in particular years. Clustering in smaller, larger or differently defined space and/or time units could have gone undetected, but based on present results, such clustering seems unlikely. These findings agree with those of Froggatt (6) that, in general, no specific years contain an inordinate number of SIDS cases when compared with other years in various geographical units.

This report summarizes a more detailed report prepared by Delton Atkinson in partial fulfillment of the requirements for the degree of Master of Public Health in the Department of Biostatistics, University of North Carolina at Chapel Hill. Mr. Atkinson interned in the Public Health Statistics Branch during June-August 1979. Copies of his original report are available.

Readers should also be apprised that, subsequent to this study, other researchers are involved in 1) depicting spatial patterns of SIDS and 2) case-control studies of SIDS using medical examiner reports. We hope to report findings of these investigations at some future time.

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